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(54) **Cable reeling apparatus for a remotely controlled mobile vehicle.**

(57) A remotely controllable mobile vehicle includes a cable reeling apparatus which permits relative rotation between each of the vehicle body, a cable reel and a remotely controllable mechanism mounted on the vehicle body. The cable reel and the remotely controllable apparatus are coaxially mounted about an upright axis on the vehicle body and signals for control of the vehicle and its remotely controllable apparatus are transmitted via the cable to a signal detection means associated with the vehicle body.

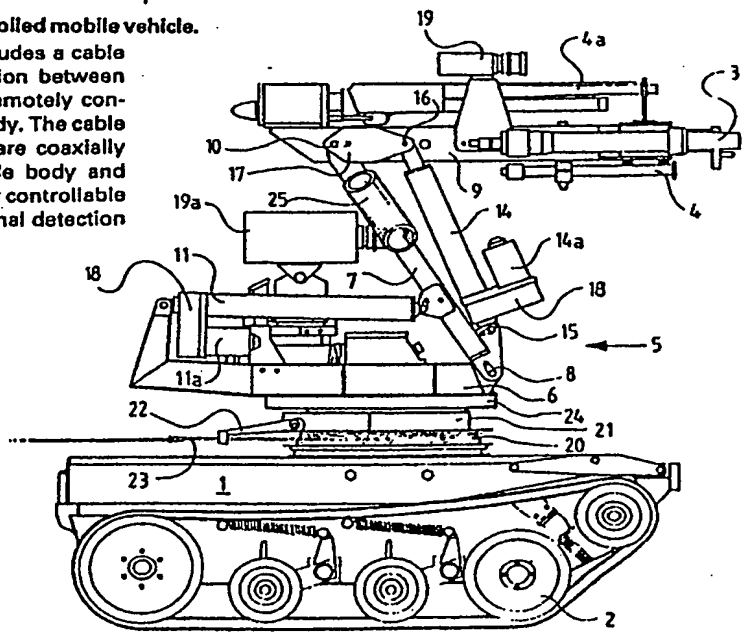

FIG. 1

EP 0 230 720 A2

Croydon Printing Company Ltd.

Cable Reel.

THIS INVENTION is concerned with a cable reeling device which is particularly although not exclusively suitable for remotely controlled mobile apparatus.

There are a wide variety of remotely controlled devices presently in use including industrial robots, explosive ordinance disposal vehicles, undergound mining equipment, submarine survey and repair vehicles and the like. Due to the environment in which many of the devices operate, remote control by transmission of electromagnetically radiated signals may not be possible. The present invention is concerned with a mobile apparatus requiring a cable link with a remote location for transmission of control signals and or operating power.

Generally speaking a mobile apparatus controlled remotely by a cable includes either a cable anchoring device whereby the cable is dragged behind the apparatus as it moves or it includes a cable drum to reel out cable during advance and to reel in cable during retreat. Both prior art systems suffer considerable disadvantages.

Devices possessing a fixed anchor system for a cable are extremely limited in operation. For example as such a device proceeds away from a remote location the friction between the cable and the ground surface increases proportionally. The device must therefore

have sufficient motive power and traction to overcome such a load. Further, such devices cannot move a tortuous path between obstacles such as trees, lamp posts or the like without snagging the cable.

Prior art apparatus having a cable reel usually has a reel mounted on a transverse horizontal axis at the rear of the apparatus. Although possession of the reel to let out or take up cable overcomes many of the abovementioned problems these mobile devices can only retreat to an original position in reverse along the path defined by the laid out cable.

Notwithstanding the problems referred to above, both types of prior art apparatus suffer the serious disadvantage that neither can execute a 360 degree turn without snagging the cable.

Accordingly it is an aim of the present invention to provide a cable reeling mechanism and a remote controlled apparatus employing same wherein the problems of the prior art devices are overcome or alleviated.

According to the invention there is provided a cable reeling apparatus comprising:-

a cable storage means rotatable about an upright axis;

mounting means for rotatably mounting said cable storage means to a mobile remotely controlled apparatus;

drive means for selectively applying a tension to a cable connected to said cable storage means; and

transfer means for transferring signals transmitted via said cable to said mobile apparatus for control thereof.

The cable storage means may comprise a cable reel rotatably mounted on an upright axis on said mounting means or it may comprise a support means rotatably mounted on an upright axis on said mounting means, said support means including a cable reel rotatably mounted on said support means and spaced from a rotational axis of said support means.

The cable reel mounted on said support means may be mounted for rotation about a transverse, upright or inclined axis.

Preferably the cable storage means includes reeving means to selectively position said cable on said cable reel during rewinding.

Suitably the mounting means is adapted to permit co-axial mounting of an operating mechanism to permit relative rotation between said cable storage means and said operating mechanism.

Preferably said drive means for selectively applying a tension to a cable includes a slip means to permit selective payout of said cable against a force applied by said drive means.

The transfer means for transferring signals to

said mobile apparatus may comprise a slip ring mechanism having mechanical contacts for transfer of electromagnetic signals or it may comprise optical detection means for transfer of signals transmitted via a fibre optic cable. Preferably the transfer means comprises an electromagnetic transmitter and a receiver for receiving signals transmitted by said transmitter, said transmitter and receiver being rotatable relative to each other.

According to another aspect of the invention there may be provided a remotely controlled mobile apparatus including a cable reeling mechanism according to the aforesaid aspect of the invention.

In order that the invention may be clearly understood it will now be described with reference to an explosives ordinance disposal vehicle, "E.O.D.", however it should be understood that the invention is applicable to other forms of remote controlled mobile apparatus.

A preferred embodiment of the invention is illustrated in the accompanying drawings in which FIG 1 is a side elevation of an E.O.D.

FIG 2 is a front elevation

FIGS 3 and 3a show in plan view the cable drum and reeving mechanism

FIG 4 is a partial side elevational cross

section of the mechanism shown in FIG 3 through A-A

FIG 5 is a partial cross section through B-B in FIG 3

FIG 6 is a partial cross section through C-C in FIG 3

In FIG 1 the E.O.D. comprises a body 1 having a crawler track mechanism 2 for motion over a ground surface. The crawler track mechanism is driven by a suitable drive motor (not shown) via a chain and sprocket drive or the like.

Mounted on the body 1 is an operating mechanism 5 in the form of a robotic head. The operating mechanism comprises a base 6 rotatably mounted on body 1, a pair of link arms 7 pivotally mounted at their lower end via pivot 8 to base 6 and an upper support arm 9 pivotally mounted via pivot 10 to link arm 7.

Link arms 7 are tiltable by means of electrical actuators 11 pivotally attached at one end 12 to base 6 and at their respective other ends 13 to link arm 7. Support arm 9 is tiltable relative to link arm 7 by means of further electrical actuators 14 pivotally attached at one end 15 to link arms 7 and at their respective other ends 16 to a transverse bracket 17 attached to support arm 9.

Actuators 11,14 each comprise a worm and roller assembly and respectively are powered by

electric motors 11a,14a by a suitable transfer means such as a chain and sprocket, gear train or the like 18.

Mounted on support arm 9 is a video camera 19 having a controllable pan and tilt mechanism. This camera is suitably used for gereral surveillance. A further video camera 19a, also having a controllable pan and tilt mechanism is mounted on base 6, suitably for remotely viewing a steering path for the E.O.D. If required lights may be fitted to body and/or base 6 and/or support arm 9 to enable the E.O.D. to operate in a dark environment.

Mounted on support arm 9 are water cannon nozzles 3 a projectile emitting device such as a "nail gun" 4 and a rifle or shotgun 4a.

The support arm 9 may be adapted to receive a variety of remotely actuable devices for crowd control purposes, handling or disposal of explosive devices. Such devices may include extendable robotic arms or the like.

Mounted on opposed sides of link arms 7 are resilient buffers 25 to protect the robotic head 5 in the event that the apparatus capsizes.

Rotatably mounted intermediate the robotic head 5 and the body 1 is a cable reel 20, a housing 21 for a reeving mechanism and a cable reeving arm 22. Cable 23 passes through reeving arm 22 and is

accumulated on cable reel 20. Between robotic head 5 and housing 21 is situated a further housing 24 encasing a gear drive mechanism for rotating the robotic head 5. A drive motor (not shown) for rotating head 5 is mounted on head 5 and the drive mechanism is operable via a gear train and pinion (not shown) which engages a ring gear within housing 21.

The cable reel 20, the reeving mechanism including reeving arm 22 and housing 21, and the robotic head 5 are all rotatable relative to each other and to body 1 about a common axis shown generally at 27.

FIG 2 shows a front elevation of the apparatus of FIG 1.

FIG 3 shows a schematic plan view of the cable reeving mechanism.

A hollow tubular post 26 is rigidly mounted to the body 1 of the apparatus and its central axis 27 is the rotational axis for cable reel 20, housing 21 and robotic head 5. The cable reel 20 is represented by an inner wall 28 and peripheral flanges 29. A shouldered recess 30 provides a mounting for a terminal connection 31 for cable 23.

As cable reel 20 rotates to take up or pay out cable a ring gear 32 associated with reel 20 engages a gear train represented by gears 33, 34 and 35. Gear 35 is supported for rotation on a shaft 36 having an

eccentric boss 37. Journalled on boss 37 is a link arm 38 pivotally connected to a lever 39 which in turn is connected to a rockable shaft 40 journalled in bearings 41. Reeving arm 22 is fixed on shaft 40 by a suitable fixing means such as a grub screw (not shown) or the like. At the remote end of the reeving arm are four journalled rollers 25 oriented as spaced pairs on perpendicular axes.

In use, as reel 20 rotates, motion is transferred from ring gear 32 via the gear train to gear 35. As gear 35 rotates, its rotary motion is translated into a reciprocating motion in arm 38 which causes reeving arm 22 to rock at a predetermined rate to reeve the cable neatly onto reel 20.

FIG 5 is a cross section through A-A in FIG 4.

The housing 21 for the reeving mechanism is rotatably mounted on hollow tubular post 26 by a bearing assembly 42 and similarly cable reel 20 is rotatably mounted on post 26 by a further bearing assembly 41.

Cable reel 20 comprises a pair of annular plate like flanges 43, 44 rivetted to a central hub 45 in which bearing assembly 41 is held. On the inner wall 46 of reel 20 is mounted a device for indicating when only a few turns of cable are left on the reel. The device comprises a plunger 47 biassed by a coil spring 48 towards the interior of the reel cavity.

Connected to plunger 47 is an arm 49 slidably mounted on reel flange 44 via sliding bearings 50. The remote end 51 of arm 49 is adapted to actuate a sensor 52 in the form of a proximity switch, micro switch or the like mounted on the upper surface of body 1 when due to the absence of cable turns on the inner wall 46, the plunger 47 is allowed to move towards the reel cavity. The biassing force of spring 48 is chosen such that the normal tension on the initial layers of cable turns on the reel 20 is sufficient to maintain the plunger in a retracted state. Sensor 52 is adapted to send an appropriate signal when actuated to a remote control position via cable 23.

Cable reel 20 is rotated by a constant torque electric motor 25 (shown in FIG 1) via a pinion 53 mounted on the motor drive shaft. Pinion 53 engages with a ring gear 54 fixed to the lower face of reel flange 44. By incorporating a constant torque drive, cable reel 20 is able to be driven continuously whereby as the mobile apparatus advances away from a remote control point, cable is paid out from reel 20 against the torque applied by the reel drive motor. Similarly as the mobile apparatus retreats, the torque applied by the reel drive motor ensures that the cable is rewound on reel 20.

Alternatively the cable reel system may incorporate a motion detector means to determine motion and the direction of rotation of the reel. If the

motion detector ascertains that the vehicle is stationary or that cable is being unwound, power to the reel drive motor is disconnected until the next control command is given. Payout of the cable is controlled by frictional forces in the gear train connected to the reel drive.

The reeving mechanism is driven by rotation of cable reel 20. Mounted on reel hub 45 is a ring gear 55 which engages gear 33 in the gear train shown in FIG 4. Gear 33 is mounted on a shaft 56 which is journalled in bearings 57 in the housing 21 for the reeving mechanism. Motion is transmitted to gear 34 via a pinion 58 on shaft 56.

A plurality of seals 59 are provided between the relatively rotatable components i.e. body 1, reel 20, housing 24 and post 26 to keep dust, moisture and other contamination away from the operative components.

In order that control signals may be transmitted to the apparatus and/or information transmitted from the apparatus to a remote control site, the free end of the cable 23 is connected to a radio frequency transmitter/receiver 60 adapted for rotation with reel 20 or alternatively a conventional slip ring system. The transmitter/receiver communicates with a similar receiver/transmitter 61 mounted on body 1. Connections to electrical controllers and the video cameras 16 and 18 on the robotic head 5 as well as any other electrically

operated apparatus is conveniently made by electrical conductors (not shown extending up the hollow interior of post 26).

FIG 6 shows a cross section through B-B in FIG 4. This illustrates the mounting of gear 34 on a shaft 62 in bearing 63 in housing 21. Motion is transmitted from gear 34 to gear 35 via a pinion 64.

FIG 7 shows a cross section through C-C in FIG 4. This illustrates the translation of rotary motion imparted in gear 35 to a reciprocating motion in arm 38. Gear 35 is mounted on a shaft 36 journalled in bearings in housing 21. The intermediate portion of the shaft 36 includes an eccentric lobe 37 which in turn is journalled in a bearing 65 in arm 38. As gear 35 rotates the eccentric lobe 37 causes arm 38 to oscillate.

As the mobile apparatus (to which the invention relates) moves away from a remote control position, cable is paid out against the friction of the reel drive. The mobile apparatus is able to rotate about a 360 degrees vertical axis without snagging the cable as the cable has a constant tension applied to it at all times during operation. Similarly the robotic head is able to rotate relative to the body 1 of the mobile apparatus, again without snagging the cable. It can be seen therefore that in use the mobile apparatus is able to operate without the limitations of prior art

mobile apparatus remotely controlled by a signal and/or power cable.

In the present apparatus it is preferred to provide a source of electrical power in the form of batteries located within the body 1. Accordingly cable 23 may be simply a light multi-cored conductor or a co-axial cable for transmission of coded signals to and from the mobile apparatus. By utilizing a closely located transmitter/receiver arrangement instead of an electrical slip ring, the problems of signal corruption due to dust or moisture contamination and mechanical wear are largely eliminated. The close proximity of the transmitter/receiver enables the use of low power radio frequency control signals which reduces the risk of detection for signal jamming purposes and also reduces the risk of inadvertent actuation of an explosive device by the control signals. By utilization of fibre optic cables and suitable signal detection/transmission devices the abovementioned risks are effectively eliminated entirely.

In a further embodiment of the invention the cable storage means may comprise a platform or the like mounted for relative rotation about a common rotational axis with and between the vehicle body 1 and the robotic head 5. At a remote end of the platform may be mounted a cable reel of the type hereinbefore described or a cable reel mounted upon a horizontal axis. Such a

device having a horizontally mounted cable reel will enable the use of a very large cable reel to permit remote operation of the vehicle at great distances from the remote control station.

It will be clear to a skilled addressee that many modifications and variations are possible without departing from the spirit and scope of the invention.

CLAIMS

1. A cable reeling apparatus for a remotely controlled mobile vehicle, said cable reeling apparatus comprising:-

a cable storage means rotatable about an upright axis;

mounting means for rotatably mounting said cable storage means to a mobile remotely controlled vehicle;

drive means for selectively applying a tension to a cable connected to said cable storage means; and,

transfer means for transferring signals transmitted via said cable to said mobile apparatus for control thereof, said cable reeling apparatus characterized in that said cable storage means is rotatable through 360 degrees relative to said vehicle and a remotely controllable apparatus mounted on said vehicle, said cable storage means and said remotely controllable apparatus being coaxially mounted on said vehicle.

2. A cable reeling apparatus according to claim 1 wherein said cable storage means comprises a cable reel mounted upon an upright axis on said mounting means.

3. A cable reeling apparatus according to claim 1 wherein said cable storage means comprises a support means rotatably mounted on an upright axis on said mounting means, said support means including a cable reel rotatably mounted on said support means and spaced from the rotatable axis of said support means.

4. A cable reeling apparatus according to claim 2 wherein said cable reel is mounted for coaxial rotation relative to said vehicle and said remotely controllable apparatus.

5. A cable reeling apparatus according to claim 4 wherein said drive means comprises a constant torque motor for selectively applying tension to a cable connected to said cable reel and means are provided to allow payout of cable against a predetermined force.

6. A cable reeling apparatus according to claim 5 wherein the transfer means for transferring signals to said remotely controllable vehicle comprises a slip ring mechanism having electrical contacts for transfer of electromagnetic signals.

7. A cable reeling apparatus according to claim 5 wherein the transfer means comprises optical detection means for transfer of signals transmitted via a fibre optic cable.

8. A cable reeling apparatus according to claim 5 wherein the transfer means comprises an electromagnetic transmitter and a receiver for receiving signals transmitted by said transmitter, said transmitter and receiver being rotatable relative to each other.

9. A remotely controllable vehicle including a cable reeling mechanism according to any preceding claim.

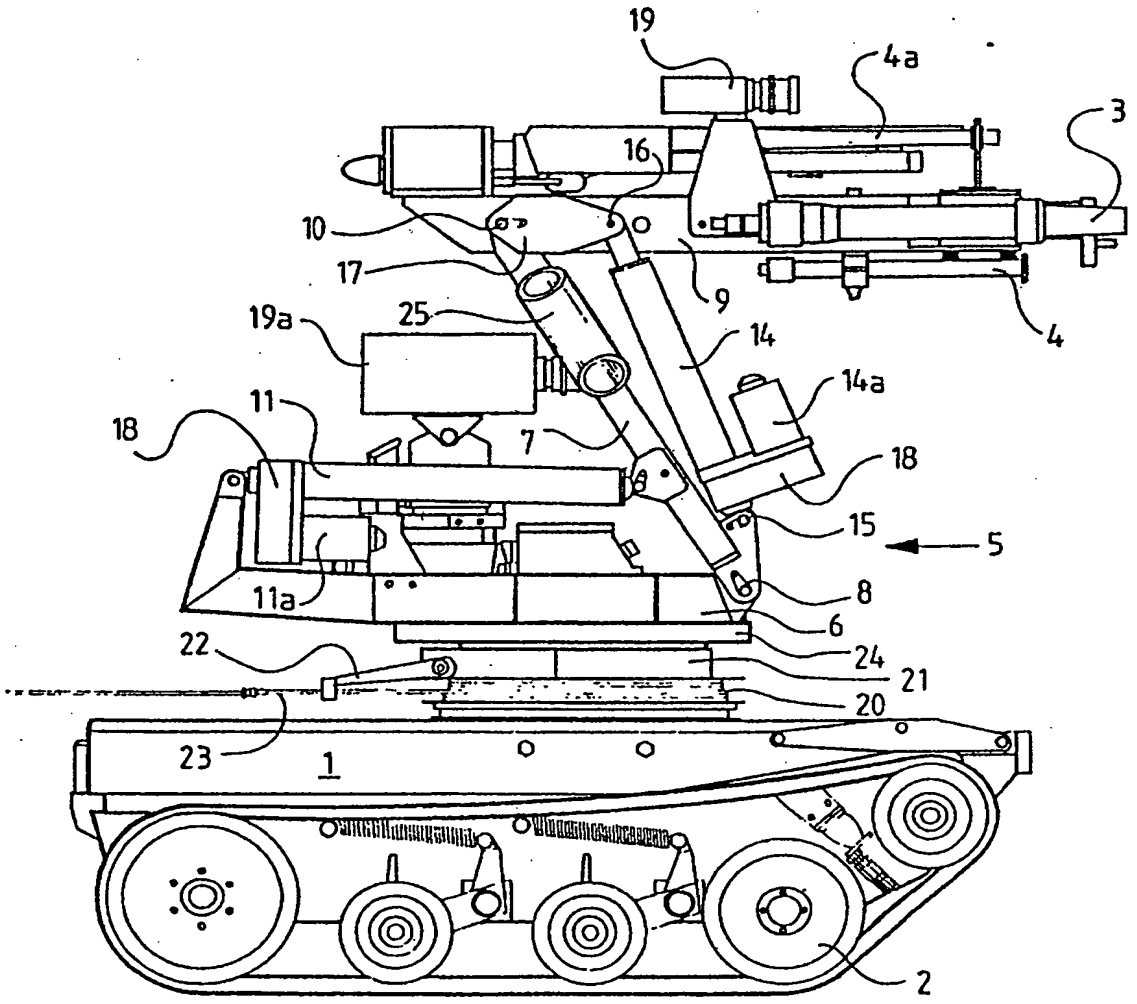

FIG. 1

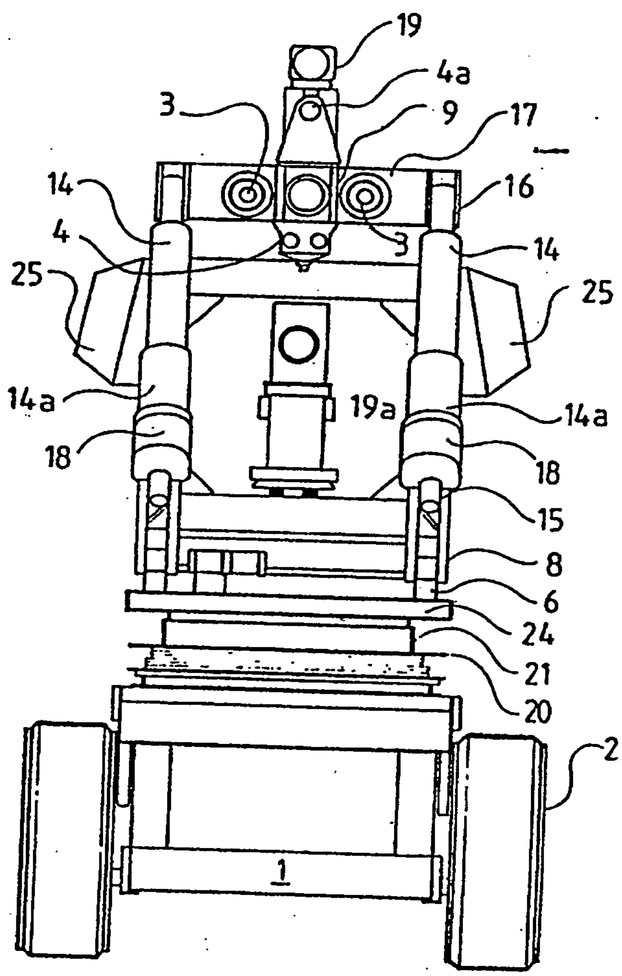

FIG. 2

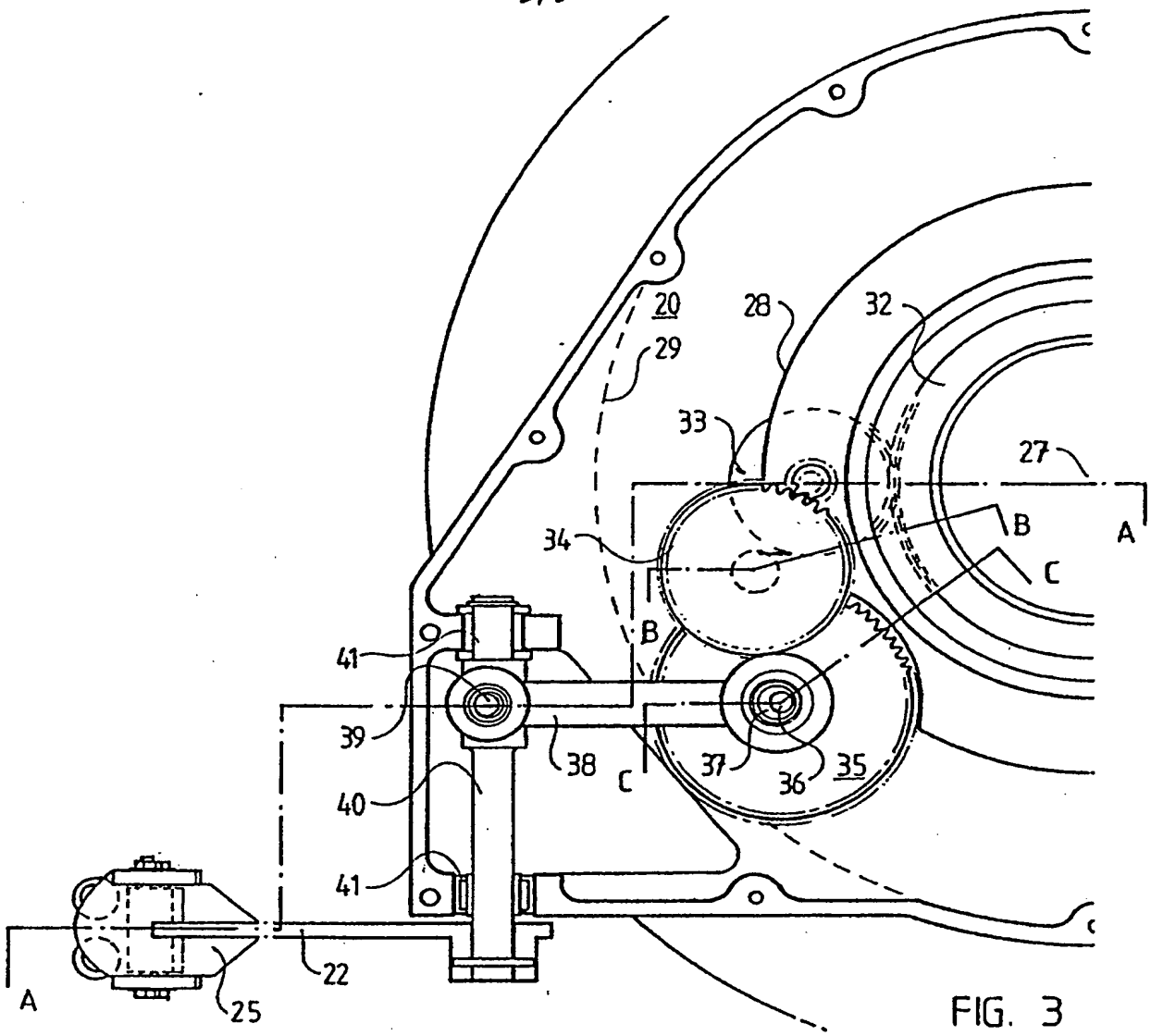

FIG. 3

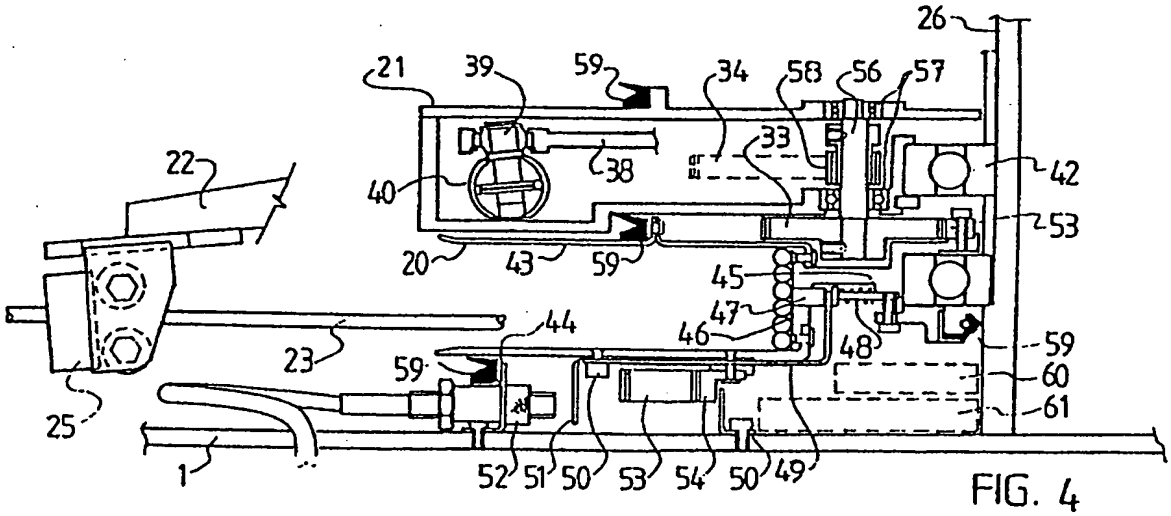

FIG. 4

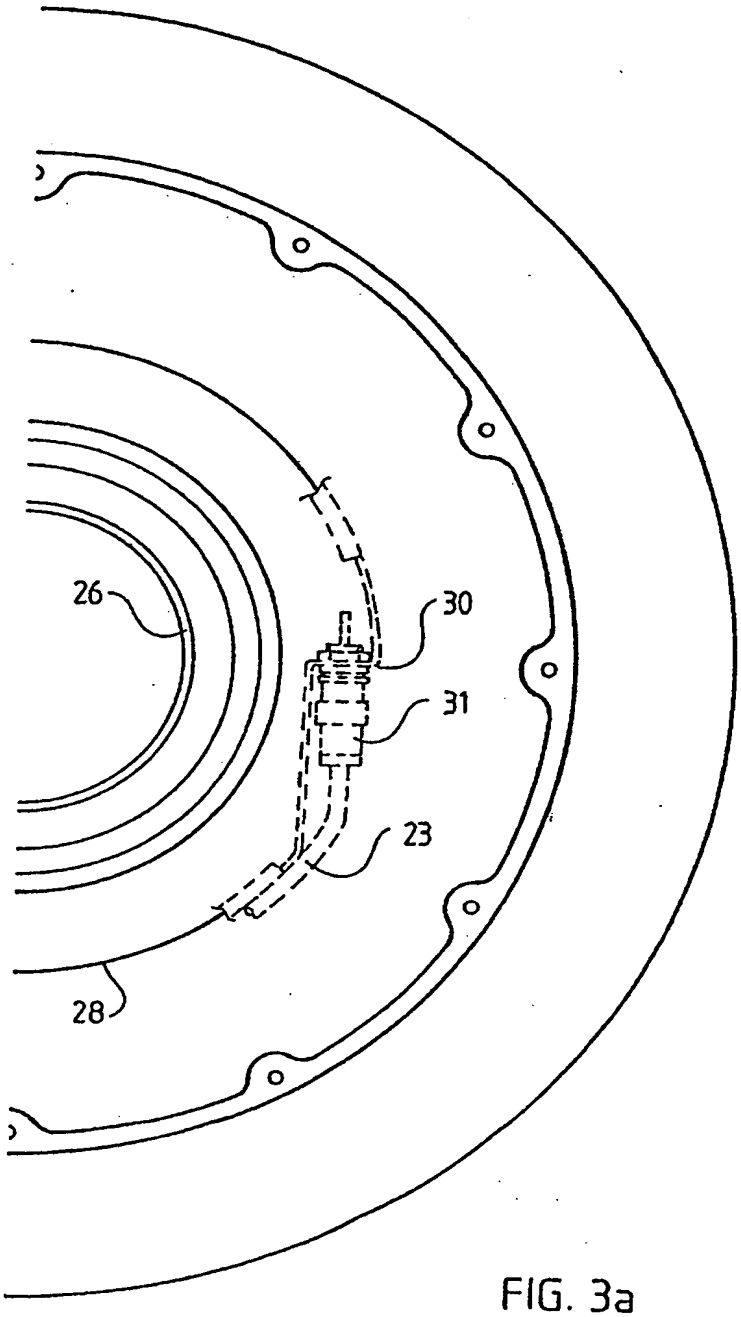

FIG. 3a

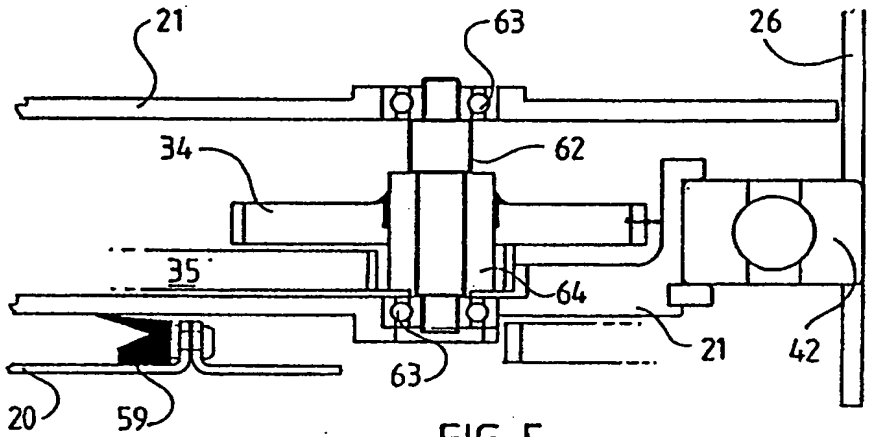

FIG. 5

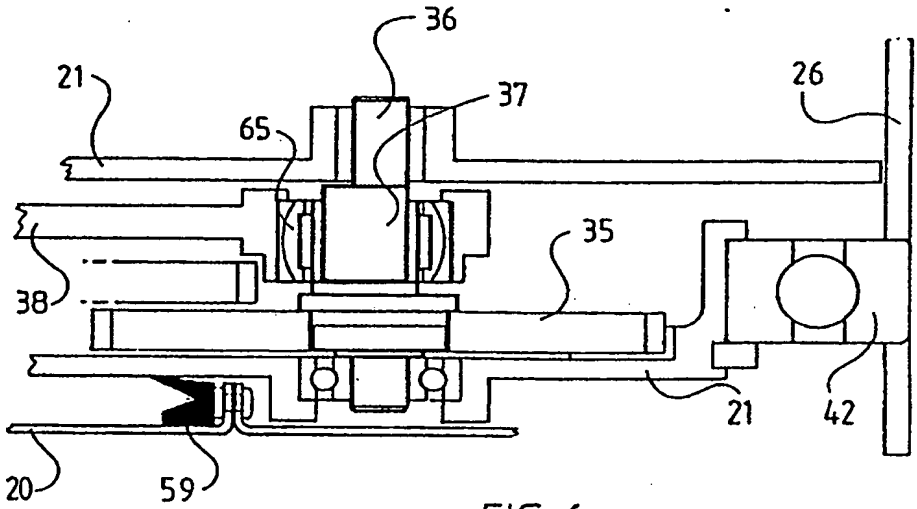

FIG. 6